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APPENDIX M: USE OF PROPOSED MATERIAL ON THE NATIONAL IGNITION FACILITY

M.1 INTRODUCTION

The U.S. Department of Energy's (DOE's) National Nuclear Security Administration (NNSA) is building the 192-beam National Ignition Facility (NIF) at the Lawrence Livermore National Laboratory (LLNL). The primary goals of the NIF are to achieve fusion ignition in the laboratory and to conduct high-energy density experiments in support of national security and civilian applications. The NIF will provide NNSA with the ability to evaluate weapon performance issues to ensure that the Nation's nuclear deterrent remains safe and reliable without underground nuclear testing.

M.1.1 History

The potential impacts of the construction and operation of the NIF were evaluated in the Stockpile Stewardship and Management (SSM) Programmatic Environmental Impact Statement (PEIS) (DOE/EIS-0236) (DOE 1996a). A project-specific analysis of the NIF was included in the SSM PEIS as an appendix. The SSM PEIS Record of Decision (61 FR 68014), published in the *Federal Register* (FR) on December 26, 1996, documented the decision to construct and operate the NIF at LLNL. In May 1997, the Natural Resources Defense Council (NRDC) and 39 other organizations brought suit against DOE in *NRDC v. Pena,* Civ. No. 97-936 (SS) (D.D.C.), challenging the adequacy of the SSM PEIS. In January 1998, the plaintiffs amended their complaint and alleged that the potential environmental impacts of experiments using certain hazardous and radioactive materials on the NIF were not adequately analyzed in the SSM PEIS. As a result, DOE filed the *Supplement Analysis for Use of Hazardous Materials in NIF Experiments* (DOE/EIS-SA0236-SA2) (DOE 1998c) with the court, which addressed the use of plutonium and other hazardous materials. The supplement analysis provided the basis for approval of the use of depleted uranium on the NIF and indicated that there was no new information to warrant the preparation of a supplemental SSM PEIS.

On August 19, 1998, the judge in the lawsuit issued a Memorandum Opinion and Order (USDCDC 1998) that dismissed the plaintiff's case. The Memorandum Opinion and Order provided in Paragraph 6 that:

> No later than January 1, 2004, DOE shall (1) determine whether any or all experiments using plutonium, other fissile materials, fissionable materials other than depleted uranium (as discussed in the *Supplement Analysis for the Use of Hazardous Materials in NIF Experiments*, A.R. doc. VII.A-12), lithium hydride, or a Neutron Multiplying Assembly (NEUMA), such as that described in the document entitled *Nuclear Weapons Effects Test Facilitization of the National Ignition Facility* (A.R. doc VII.A-4) shall be conducted in the NIF; or (2) prepare a Supplemental SSM PEIS, in accordance with DOE NEPA regulation 10 CFR §1021.314 analyzing the reasonably foreseeable environmental impact of such experiments. If DOE undertakes the action described in subpart (2) of this paragraph, DOE shall complete and issue the Supplemental SSM PEIS and the Record of Decision based thereon within eighteen (18) months after issuing a notice of intent to prepare the Supplemental SSM PEIS.

NNSA has chosen to use the *Site-wide Environmental Impact Statement for Continued Operation of Lawrence Livermore National Laboratory and Supplemental Stockpile Stewardship and Management Programmatic Environmental Impact Statement* (LLNL SW/SPEIS) as the mechanism for complying with the court's instruction to prepare a supplemental SSM PEIS. The inclusion of this supplemental SSM PEIS in the LLNL SW/SPEIS ensures timely analysis of these proposed experiments within the environmental impacts being evaluated for the continued operation of LLNL. The basis for the analyses in this document was a letter from NNSA (DOE 2001e) to the LLNL Associate Director for NIF Programs requesting that a consolidated technical recommendation be developed by the three NNSA weapons laboratories regarding possible experiments on the NIF using any of the materials indicated in Paragraph 6 of the Memorandum Opinion and Order. The requested tri-weapons laboratory recommendation (LLNL/NIF 2002a) represents the combined input of the Weapons Associate Directors at LLNL, Los Alamos National Laboratory, and Sandia National Laboratories. A classified annex containing the classified details of the proposed experiments was also provided by the Associate Directors (LLNL/NIF 2002b). NNSA evaluated the recommendation and the NNSA Deputy Administrator for Defense Programs determined that NNSA would propose to conduct experiments on the NIF using plutonium, other fissile materials, fissionable materials, and lithium hydride (Crandall 2002). There is no NNSA proposal regarding the use of a Neutron Multiplying Assembly on the NIF.

M.1.1.1 *Nonproliferation and Treaty Compliance*

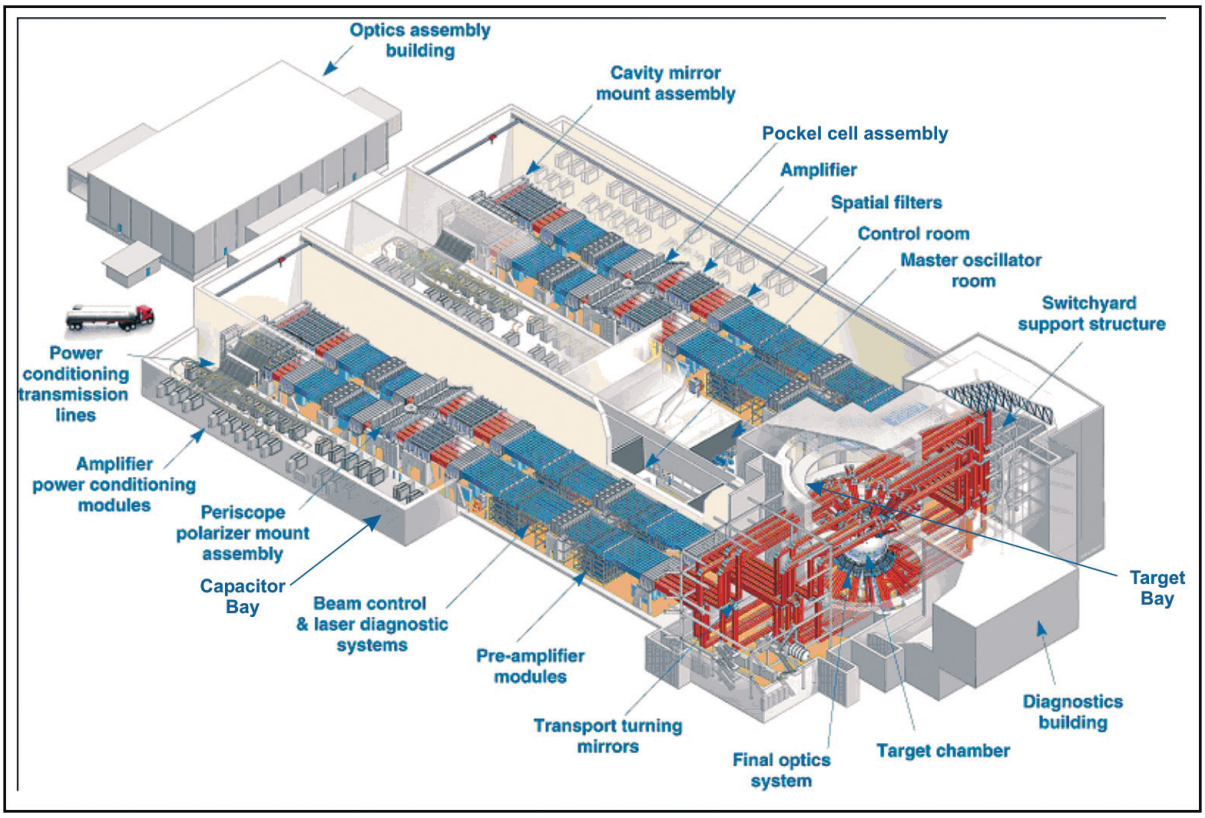
NIF is an integral part of the Stockpile Stewardship Program (SSP) and as such is considered during the review for treaty compliance and nonproliferation aspects of the SSP. Appendix I of the SSM PEIS provided an evaluation of the construction and operation of the NIF. As indicated in Chapter 1 of Appendix I, one of the objectives of the SSP is "Ensurance that the activities needed to maintain the Nation's nuclear deterrent are consistent with the Nation's arms control and nonproliferation objectives." Nonproliferation issues were evaluated for NIF in a study *The National Ignition Facility and the Issue of Nonproliferation* (DOE 1995b). The study, prepared by the DOE Office of Nonproliferation and National Security, concluded that (1) the technical proliferation concerns at NIF are manageable and therefore can be made acceptable, and (2) NIF can contribute positively to U.S. arms control and nonproliferation policy goals. NNSA has since determined that the use of fissile material, fissionable material, and lithium hydride in NIF experiments as detailed in this appendix does not change the 1995 conclusions.

M.1.2 Project Description

The construction of the NIF conventional facilities is complete; installation of the laser, diagnostic equipment, and target area equipment is in progress; and experiments have been conducted. Laser driven experiments are conducted in the NIF Laser and Target Area Building, the main building of the NIF. The Laser and Target Area Building consists of two laser bays, two optical switchyards, a target chamber in a shielded target bay, target diagnostics areas, four capacitor bays, mechanical equipment areas, control rooms, and operational support areas (see Figure M.1.2–1).

Housed in the Laser and Target Area Building is a 192-beam, neodymium glass laser, which delivers laser light of the required frequency and energy to small targets that are mounted in a 10-meter diameter aluminum alloy vacuum chamber. The target area provides all systems necessary to support the experiments: target chamber, target emplacement, target diagnostic

inserters, support structures, environmental protection systems, and support systems. The target chamber confines the radiation and debris generated by each experiment and borated concrete shielding on the chamber surface and in the target bay attenuates neutron and secondary radiation to acceptable levels during fusion ignition experiments that produce measurable neutron yield (yield experiments) and further prevents unacceptable levels of induced radioactivity. At the center of the chamber is a target, precisely located by the target emplacement and positioning/alignment system. A cryogenic target system to characterize, and position cryogenic targets will be installed in the target area. An integrated computer control system will control the laser and collect data from laser diagnostic equipment. These systems are supported by electrical power conditioning, diagnostic computer control systems, utilities, and mechanical and auxiliary support systems. Environmental protection systems have been designed to meet key functional requirements, such as limiting tritium inventory and tritium release to the environment. These systems are located adjacent to the target bay and consist of tritium processing systems (which recover tritium onto dryer beds for later disposal or recycling), cleaning and decontamination systems, radiation and tritium monitoring systems, and waste packaging and characterization facilities.



Source: LLNL File Photo 40-00-0996-2100A.

FIGURE M.1.2–1.—*National Ignition Facility Laser and Target Area Building Layout*

The Optics Assembly Building, located adjacent to the Laser and Target Area Building, includes optics processing equipment and general cleaning and precision cleaning equipment. Cleaned specialty optical components are assembled into components known as line-replaceable units in the Optics Assembly Building (Figure M.1.2–2). These line-replaceable units are then placed into canisters for transport and insertion into the laser system.

Other required support facilities, such as assembly areas; maintenance areas; optical, electrical, machine, and mechanical shops; and offices are located nearby. In addition, the inertial confinement fusion research and development laboratories and LLNL institutional facilities such as target fabrication, waste management, central plant, development support laboratories, optics processing, and transporters are located nearby.

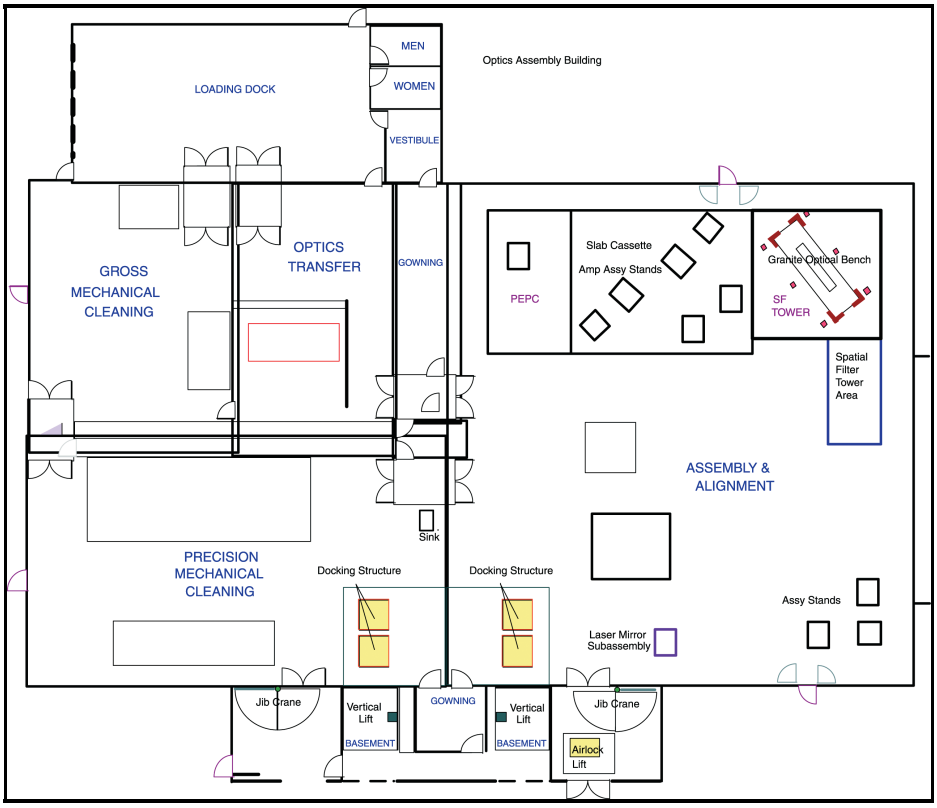
M.1.3 National Ignition Facility Operations

Experiments on the NIF for stockpile stewardship will begin in parallel with the installation and commissioning of the 192 beam lines. Figure M.1.3–1 provides a timeline for equipment installation and shows the approximate schedule for target physics experiments through 2020. The first phase of testing will include using asymmetric arrangements of the NIF laser beams and will not require the use of tritium or result in neutron yield. As laser beams become available, pre-ignition experiments will begin to assess issues of beam pointing stability, power balance, and timing. Limited amounts of tritium will be used and modest neutron yields will be produced in these types of experiments. Once fully operational with 192 beam lines, the NIF will have the capability to perform the full range of target physics experiments leading up to and including ignition and burn with energy gain. First ignition experiments for NIF are planned for 2010. The NIF will also allow researchers to field experiments studying weapons physics, weapons effects, inertial fusion energy, and basic science.

M.1.4 Purpose of this Appendix

This appendix updates the environmental impacts of future operation of the NIF discussed in the NIF project specific analysis portion of the SSM PEIS. In addition, this appendix evaluates the proposed use of plutonium, other fissile and fissionable materials, and lithium hydride and the construction and operation of a neutron measurement device called the neutron spectrometer. Analysis of the proposal to use fissile and fissionable material and a neutron spectrometer will be based on conceptual design information, because NNSA does not have detailed designs for these experiments or the diagnostic instruments. However, sufficient information is available to analyze the reasonably foreseeable environmental impacts of these experiments and the neutron spectrometer. The analysis provided in this appendix will bound the operations of the NIF.

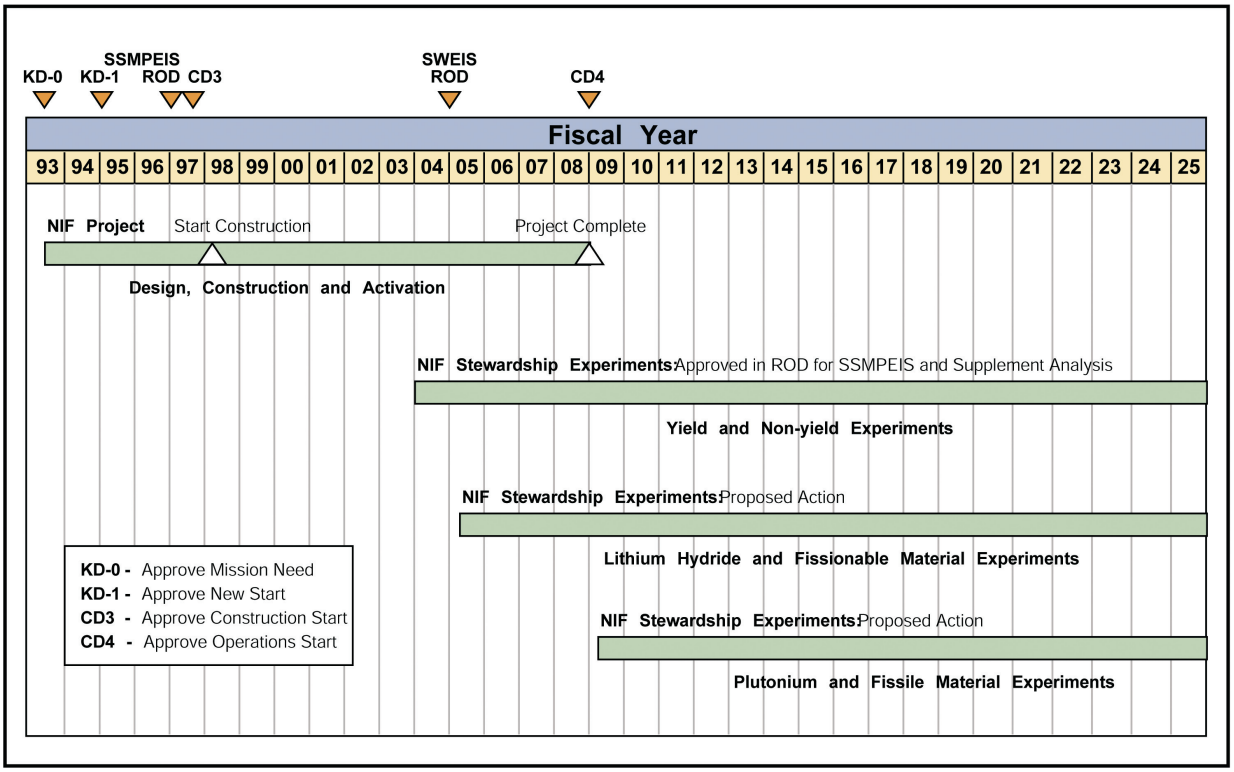
This appendix describes the NIF and its purpose and need as well as the purpose and need for the use of proposed materials; considers the No Action Alternative, Proposed Action, and Reduced Operation Alternative; assesses potential environmental impacts; and addresses mitigation measures.



Source: LLNL File Photo LLNL/NIF-1103-07481.

FIGURE M.1.2–2.—*National Ignition Facility Optics Assembly Building Layout*

NNSA has chosen to use the LLNL SW/SPEIS as the mechanism for complying with the court instruction to prepare a supplemental SSM PEIS. The inclusion of this appendix in the LLNL SW/SPEIS ensures timely analysis of the proposed experiments within the environmental impacts being evaluated for continued operation of LLNL. In the Record of Decision, NNSA will announce its decisions on the use of these proposed materials for NIF experiments.



Source: Original.
Note: See page 20 for a discussion of the terms fissile and fissionable.

FIGURE M.1.3–1.—*National Ignition Facility Timeline and Relation to Use of Certain Proposed Materials*

M.2 PURPOSE AND NEED

M.2.1 National Ignition Facility Purpose and Need

In January 1993, the Secretary of Energy approved the justification of mission need for the NIF as a part of approval of Key Decision 0 (Reis 1993). Figure M.1.3–1 shows the timeline for approval of the key decisions for NIF. The justification stated that the NIF was being proposed to support the inertial confinement fusion program requirement to achieve ignition and propagation of thermonuclear fusion and burn. In October 1994, the Secretary of Energy approved Key Decision 1 that verified the mission need for the NIF (Reis 1994). The mission areas identified in Key Decision 1 were nuclear weapons physics, inertial fusion energy science and technology, and other applications. The nuclear weapons physics discussion stated that "In the absence of underground testing, the NIF would be a critical tool for the Department's Science-Based Stockpile Stewardship Program."